

VIII. *On the Colonisation of New Nests of Ants by Myrmecophilous Coleoptera.* By H. ST. J. DONISTHORPE, F.Z.S.

[Read June 2, 1909.]

IN a letter, dated January 19th, 1876, to Professor Forel, Charles Darwin wrote—"I hope you will allow me to suggest an observation, should any opportunity occur, on a point which has interested me for some years—viz., how do the Coleoptera which inhabit the nests of ants colonise a new nest? Mr. Wallace, in reference to the presence of such Coleoptera in Madeira, suggests that their ova may be attached to the winged female ants, and that these are occasionally blown across the ocean to the island. It would be very interesting to discover whether the ova are adhesive, and whether the female Coleoptera are guided by instinct to attach them to the female ants; or whether the larvae pass through an early stage, as with *Sitaris* or *Meloe*, or cling to the bodies of the females. This note obviously requires no answer. I trust that you continue your most interesting investigations on ants." ("More Letters of Charles Darwin," 1903, vol. ii, p. 11.)

Professor Poulton, when calling my attention to the passages quoted above, suggested that I should endeavour to answer this question. The following paper is the result.

In this, the hundredth anniversary of the birth of the illustrious Darwin, it is especially appropriate to bring together all the available evidence bearing on the subject. This question shows, as usual, Darwin's wonderful insight into the most interesting and arresting problems in natural history, and his clearness of thought in at once putting his finger on the most important point in them.

This paper only deals with such species as are truly myrmecophilous in their habits, that is to say, those which are almost invariably found with ants, and not those which are more often found elsewhere. With the latter I have dealt in a previous paper (Trans. Ent. Soc. Lond., 1909, p. 397).

The actual seeking of new nests, and oviposition in them by ants'-nest beetles, are almost impossible to

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observe in the wild state. Exception may perhaps be found in such species as *Cetonia floricola*, and *Clythra quadripunctata*, which only inhabit the nests in the larval and pupal states. The methods of colonisation are furthermore very different according as the different species of beetles belong to the different categories of true guests, hostile persecuted lodgers, or indifferently treated lodgers. The first of these supplying their hosts with a sweet secretion and fed by them, naturally come into much closer relationship with the ants than any of the others. In order to give anything like a satisfactory answer to Darwin's question we really require to study the whole life history of ants'-nest beetles and their connection with their hosts.

When an ants' nest is disturbed a scene of apparent chaos ensues: the ants all rush about, some attacking the intruder, others hurrying off into safety, with their brood, and with the true guests and their larvae. Their other guests likewise endeavour to escape: some "feign death," while others seek the interior of the nest. It is obvious that in such a scene we can gain no insight into the normal procedure of a fresh colonisation, and are therefore forced to rely on evidence obtained from observation nests, and experiments on ants'-nest beetles, and on beetles bred in such nests; on their pairing habits, and on when and where one finds the beetles, their larvae, etc. It is necessary to consider all records of true myrmecophilous beetles found at large, away from ants' nests; and of all specimens found with ants other than their usual hosts. These latter examples will afford evidence that the beetles not only have not returned to the nest in which they were bred, but have not even sought the same species of ants. The rarity of such records tends to prove that ants'-nest beetles are as a rule very constant in associating with their regular hosts. I would also remark that it is most important that all records of ants'-nest beetles should be accompanied by full and accurate data, stating the number of specimens taken, the exact date, and the species of ant with which the beetle occurred. Without these facts the subject cannot be investigated with any hope of success.

Many species no doubt simply fly direct to a new nest, either to deposit their eggs in it, or from the necessity of pairing with other individuals of their own species. Besides this they may reach new nests by the following

means:—(1) by leaving a nest in company with their hosts when the latter seek a new one, the true guests being perhaps * carried by, or riding on the ants, the other species running along with them; (2) by a nest being captured by another colony which may kill off the original holders, and live in their domicile, or during the so-called slave-making raids, when the marauders not only capture and carry off the brood of the other ant, but also the beetle larvae in the nest; (3) by attaching themselves to winged female ants they might be carried out during the marriage flight and thus come to inhabit the new nest founded by this female. In other cases when the ants fall to the ground, the guests might enter some neighbouring nest, or be taken in by its ants. There is finally Wallace's suggestion in the letter to Darwin referred to above—that the ants'-nest beetles occurring in Madeira might have been introduced as ova attached to winged queen ants occasionally blown over to the island.

In order to test the above hypotheses I propose to consider the evidence afforded by some of the ants'-nest beetles which occur in Britain.

Homoeusa acuminata, Märk.

Normal hosts.—*Lasius niger*, L., and *L. fuliginosus*, Ltr. Wollaston took this species in a nest of *Formica fusca*, L. near Bromley, in 1856 (Zool. 1856, p. 5178), and several specimens again in 1857.

Chitty and I took a few specimens with the same ant at Doddington, Kent, May 12th, 1901 (E. M. M. 1902, p. 74).

I took a specimen at Mickleham in a mixed nest of *Lasius flavus* and *niger* under a stone May 27th, 1900. As it is unusual for these ants to live together, they were probably encroaching on each other, and eventually the one might exterminate the other. Should *L. flavus* have been the victor, we might thus account for a specimen occurring in a nest of this ant.

O. E. Janson took a specimen running on a bank at the

* A. R. Wallace, in a letter to Darwin (*l. c.* p. 19) remarks: . . . "it may well be that the ova, or larvae, or imagoes of the beetles are not carried systematically by the ants, but only occasionally, owing to some exceptional circumstances. This might produce a great effect in distribution, yet be so rare as never to come under observation."

base of a fence in the London district on May 16th, 1857 (Zool. 1857, p. 1768).

A specimen was swept near Tonbridge, by Horner (E. M. M., 1885, xxii, p. 88).

Chitty took two specimens in the spring of 1894, near Doddington, in cart-ruts, full of water, and I took another specimen in the same cart-ruts in May 1901 (E. M. M., 1902, p. 74).

We see by this that *Homocusa* leaves the nests in the spring, probably for pairing and to seek new nests. Father Hugger has seen the pairing of this beetle in an observation nest of *L. niger* (Wasmann). It is very like a *Dinarda* in its habits and belongs to the indifferently treated lodgers. Father Wasmann has occasionally seen the licking of the beetle by its hosts, *L. niger*, and shows that when introduced into strange nests of the same ant it is at least tolerated.

Oxyptoda vittata, Märk.

Normal host.—*Lasius fuliginosus*, Ltr.

Father Wasmann once found it in some numbers with *Lasius brunneus*, in a tree in company with other guests of *L. fuliginosus*. The *brunneus* must have taken possession of a tree that had been occupied by the latter ant. He also took a single specimen in October and a single specimen in November with *Formica rufa* in Dutch Limburg, and has seen it in some numbers flying far from a nest of *L. fuliginosus*.

Dr. Sharp records it as very rare in Scotland, and away from ants. ("Scot. Nat." II, 1873-4, p. 189.)

Walker has taken it by sweeping at Witham Park. ("Oxford List, 1906," p. 13.) It belongs to the indifferently tolerated lodgers, as do the next 8 species mentioned.

Oxyptoda formiceticola, Märk.

Normal host.—*Formica rufa*, L.

Wasmann records a single specimen taken with *F. fusca* in August in Dutch Limburg. I have bred this species in *F. rufa* observation nests.

Thiasophila angulata, Er.

Normal hosts.—*Formica rufa*, L., and *pratensis*, De G.

I took a single specimen in company with *Lasius fuliginosus* at Oxshott on May 16th, 1900. I have shown that

this beetle protects itself against the ants if attacked, as also the next species. Wasmann took one specimen in a nest of *Formica sanguinea* in May in Dutch Limburg, and has also caught it on the wing.

[NOTE.—*Formica pratensis*, De G. (*congerens*, Nyl.), appears to be very rare in Britain; it has been recorded from Bournemouth, Holnest, Porlock, Exmouth, Rannoch and elsewhere in Scotland. Possibly some of these records are in error as Saunders only gives Bournemouth and Rannoch. I have never been able to find it, but I have found nests of the subspecies *rufa-pratensis*, Forel, at Nethy Bridge, which have the colouring of *pratensis* without its hairiness.]

Thiasophilina inquilina, Märk.

Normal host.—*Lasius fuliginosus*, Ltr.

Dr. Power took a specimen with *Formica rufa* at Burnham Beeches on June 21st, 1857.

Ilyobates glabriventris, Rye (*bonnairci*, Fvl.).

This species appears to be very rare both here and on the Continent. It was taken sparingly by Dr. Power with *Lasius fuliginosus* at Mickleham in May and June 1863, in the runs of the ants in company with *Homocusa acuminata*. (E. M. M., I, 1865, p. 212.) Wasmann took it with *Lasius brunneus* in July in Dutch Limburg and remarks, "perhaps a regular guest of the ant"; also with *Lasius alienus* in Vienna. Sklitzky records it with *Lasius niger* in Bohemia.

Fauvel described it from a specimen taken by M. Bonnaire in Compiègne, but does not record how it was captured. ("Bul. Soc. Normandie," IX, 1865, p. 287.)

Mr. Elliman swept two specimens in a moist wood near the Chiltern Hills on June 6th, 1897, and remarks that the atmosphere at the time was remarkably still and warm. (E. M. M., 1897, p. 279.)

We now come to the genus *Dinarda*. Father Wasmann tells me their eggs are deposited in the soil of the nests, the larvae emerging there. The copulation of *Dinarda* is the same as that of *Lomechusa* and *Atemeles*.

Dinarda märkeli, Kies.

Normal host.—*Formica rufa*, L.

Wasmann records a single specimen in a nest of *Formica sanguinea* in May in Dutch Limburg.

I have bred this species in my observation nests of

Formica rufa, and have shown that it protects itself when introduced to strange *rufas*, or when attacked in the nest, as also do the other species.

Dinarda dentata, Gr.

Normal host.—*Formica sanguinea*, Ltr.

One specimen was taken by W. C. Jackson in a nest of *Formica exsecta* at Bournemouth. ("Ent. Rec.," 1905, p. 272.)

Wasmann found a single example in August with *F. rufibarbis* in Dutch Limburg, and has found the species running about away from ants. Douglas and Scott once found at Shirley in September 1863, "a quantity of *Formica sanguinea* running close together in one direction, and side by side with them, in nearly equal number, *Dinarda dentata*." (E. M. M., 1900, p. 11.) No doubt the ants were seeking a new habitation and the beetles had left the old nest with them. Father Wasmann found this ant in the act of leaving its nest, carrying cocoons and each other, accompanied by their slaves, *F. fusca*, also carrying cocoons, etc. Over 100 *D. dentata* were on the top of the nest in a state of excitement, running in and out of the entrances and following the ants.

Professor Wheeler records that in the neighbourhood of Würtzburg he came upon a colony of *F. sanguinea* in the act of moving to a new nest. The ants were laden with their larvae and were marching along a dusty road and in their midst two *Dinarda dentata* were running. ("Journal für Psychologie und Neurologie," Leipzig, 1908, p. 435.)

I have bred this species in numbers in my observation nest of *Formica sanguinea*, the larvae of the beetles being very plentiful at times.

Dinarda hagensi, Wasm.

Normal host.—*Formica exsecta*, Nyl.

I have also bred this species in my observation nest of its host, *Formica exsecta*, from Bournemouth.

Dinarda pygmaca, Wasm.

Normal host.—*Formica rufibarbis*, F., var. *fusco-rufibarbis*, For.

I have found the larva of this beetle in company with the imago in the nest of this ant at Whitsand Bay.

Lomechusa strumosa, F.

Normal host.—*Formica sanguinea*, Ltr.

Wasmann found it in some numbers in one nest of *Formica rufa* in Dutch Limburg in May 1897, and a single specimen with *F. rufibarbis* v. *fusco-rufibarbis*, on May 14th, 1897. Sir Hans Sloane captured a specimen on Hampstead Heath in 1710. Dr. Leach took one when travelling in the mail coach between Cheltenham and Gloucester about 1820.

One got up and flew away off the sheet I was using when examining a nest of *F. sanguinea* at Woking.

Roger records that on warm days one often sees *Lomechusa* out and walking about.

Sahlberg caught it on the wing.

Wasmann remarks that although not double-hosted like *Atemeles*, it often changes its habitation.

I have described and figured the copulation of this beetle, and I found in my observation nest that a number of specimens collected together outside the nest for this purpose, and afterwards the ♀♀ immediately entered the nest.

Father Wasmann has recorded that they collect together at pairing time, and that he once found 63 specimens sitting on the top of a nest, 6 pairs being *in cop.*, and that some days later they dispersed to other nests.

I once found under a turf at Woking a small number of *sanguinea* ♂♂, two ♀♀, and several *Lomechusa*, all evidently about to move together.

Father Wasmann has shown that the eggs of this beetle are laid on the eggs of very young larvae of the ants, and that the eggs are very like the ants' eggs and that the larvae is at most only one or two days in the egg.

The species of the genus *Atemeles* are, like *Lomechusa*, true guests, being fed* and licked by their hosts; they differ, however, in being double hosted, that is to say, their summer hosts are ants of the genus *Formica*, in which nests their eggs are laid and their larvae bred, so these ants may be called the larval hosts; their winter

* It is a very interesting fact, first pointed out by Father Wasmann, that when an *Atemeles* desires to be fed, it not only asks an ant, by tapping with its antennæ, as does *Lomechusa*, but it further imitates the actions of its hosts, by stroking the side of the head of the ant with its front foot. Any one has only to keep *Atemeles* alive to satisfy himself on this point.

hosts are ants of the genus *Myrmica*, which may be called the beetle hosts. The beetles thus have to make a double migration, one in the early part of the year from *Myrmica* to *Formica* nests, and again in summer or autumn from *Formica* to *Myrmica*. Consequently one would expect to find *Atemeles* at large more often than other regular guests, and this is exactly what does happen. The pairing time is about May, and takes place in *Formica* nests, it is the same as that of *Lomechusa*. Father Wasmann has demonstrated that the eggs of *Atemeles* are laid on the eggs of the ants, from which they are undistinguishable even with a lens. The young larvæ hatch very soon and devour the ants' eggs. Another interesting point is that the beetles go into quarantine before they enter the other hosts' nest, after leaving the one. This is several days when leaving *Myrmica*, as they remain hidden in and near the new *Formica* nest; Wasmann has often proved this in observation nests, etc. When going from *Formica* to *Myrmica* the period is much longer, as they are not found with the latter before the end of August or the beginning of September, though they have long before disappeared from the *Formica* nests. Having been bred in the latter nests, the nest aura is no doubt more pronounced in the beetles of the summer migration.

Atemeles emarginatus, Pk.

Primary hosts.—*Myrmica scabrinodis*, Nyl., *lacrinodis* Nyl., *ruginodis*, Nyl., and *sulcinodis*, Nyl.

Secondary host.—*Formica fusca*, L.

F. Smith once recorded he took a specimen which ran out of a nest of *F. rufa*. (Trans. Ent. Soc. Lond., 1842, p. 151.)

The record in Parfitt's "Col. Devon, 1867," p. 22, "in nests of *F. rufa*, Plymouth, Reading," is no doubt incorrect, as it is recorded in the "Ent. Annual" for 1858, p. 83, as taken by Reading in nests of *Myrmica rubra* near Plymouth.

Penzance district in nests of *F. rufa*. ("Vic. Hist. Cornwall," 1906, p. 190.)

Here again I expect the ant was incorrectly recorded.

Mayr once found a single specimen with *F. rufa*, and Westhoff one with *Tetramorium caespitum*.

I took a specimen by sweeping near a nest of *Formica rufa* on May 15th, 1894, at Guestling.

Champion took a specimen running across a path at Bonchurch, I. of W., in July. (E. M. M., 1887, p. 137.)

Harwood recorded the capture of a specimen in dead leaves near Colchester during the early part of the year. (E. M. M., 1898, p. 64.)

A specimen is recorded running on a chalky pathway. (Vic. "Hist. Herts., 1902," p. 90.)

J. H. Keys took a specimen on his collar at South Brent in May 1903.

Walker records one by sweeping at Headington Wick Copse in June ("2nd Oxford List, 1907," p. 53), and another in a sand-pit in the New Forest in July. (E. M. M., 1907, p. 206.)

E. A. Butler swept a specimen in August at Luccombe, in the I. of Wight.

Forel has shown that when *Formica sanguinea* and *Polyergus rufescens* make slave raids on *Formica fusca*, they not only carry off the cocoons of the latter, but also the larvae of the *Atemeles*.

Atemeles paradoxus, Gr.

Primary hosts.—*Myrmica ruginodis*, Nyl., *laccinodis*, Nyl., and *scabrinodis*, Nyl.

Secondary hosts.—*Formica rufibarbis*, F., and var. *fusco-rufibarbis*, For.

Fowler took a specimen on the cliffs near Sandown, being carried by an ant much smaller than itself, in April. (E. M. M., 1884, XXI, p. 18.) The ant was, I believe, *Lasius niger*.

H. W. Bates recorded this beetle with *Formica flava* at Sheet Hedges Wood in Leicestershire. ("Zool., 1944," p. 700.) The beetle was, however, *emarginatus*, and the ants were most probably *Myrmicas*.

Wasmann remarks that this and the last species are often found at large, running and flying.

Myrmedonia funesta, Gr.

Normal host.—*Lasius fuliginosus*, Ltr.

A specimen was taken in a fungus in Birch Wood by Curtis on May 6th, 1821. ("Zool. 1855," p. 4603.)

One captured by Linnell on Red Hill Common in 1855. ("Reigate List, 1898," p. 12.)

Wasmann once found it in some numbers moving with *Lasius fuliginosus* to a new nest at Exaeten.

Species of the genus *Myrmedonia* belong to the hostile persecuted lodgers and prey on ants. I have shown that this and other species protect themselves if attacked when introduced into new nests, and to strange ants, by the secretion which they give off.

Myrmedonia humeralis, Gr.

Primary host.—*Lasius fuliginosus*, Ltr.

Secondary hosts.—*Formica rufa*, L., and *pratensis*, De G.

Scott took it in moss at Renfrew. ("Zool. 1852," p. 3462.)

Linnell records one example at Redstone in 1855, which had probably strayed from a nest of *F. rufa*, of which there were several at that time in Redstone Wood ("Reigate List, 1898," p. 12.)

A specimen was taken by Blatch under a stone in a dry ditch at Hunstanton. (E. M. M., 1882, XIX, p. 139.)

Walker records it in faggots in the Blean Woods. (E. M. M., 1898, p. 208.)

Wasmann mentions it running on roads.

The pairing which I have recorded is like that of *Lomechusa*. ("Ent., Rec., 1908," p. 283.)

I have taken the larvae in company with the beetle and *F. rufa* near Knowle.

Myrmedonia cognata, Märk.

Normal host.—*Lasius fuliginosus*, Ltr.

A single specimen was taken by O. E. Janson on the stump of a felled tree at Hampstead on June 3rd, 1855. ("Ent. Ann., 1857," p. 72.)

One example was taken by Wasmann with *Lasius niger* in May in Dutch Limburg. He found several specimens with *Lasius brunneus* in a tree in company with other guests of *L. fuliginosus*.

On March 25th, 1886, he found specimens moving with *L. fuliginosus* at Exaeten from an old nest to a new one.

I have bred this species in my *L. fuliginosus* observation nest.

Myrmedonia lugens, Gr.

Normal host.—*Lasius fuliginosus*, Ltr.

A single specimen was taken in July with *L. brunneus*

by Wasmann in Dutch Limburg. He also took one at Exaeten moving with *L. fuliginosus* to a new nest.

G. R. Waterhouse took it at Sydenham in the spring of 1856 away from ants.

Champion records it on the wing at Woking in June. (E. M. M., 1906, p. 255.)

Myrmedonia laticollis, Märk.

Normal host.—*Lasius fuliginosus*, Ltr.

Wasmann has found it with *L. brunneus* in a tree with other guests of *L. fuliginosus*.

Champion records it on the wing at Woking in June. (E. M. M., 1906, p. 255.)

I have taken the larvae in plenty in a nest of *L. fuliginosus* at Wellington College, and have bred the beetle in numbers in my observation nest of that ant.

Wasmann records that he has seen various species of *Myrmedonia* flying in some numbers.

Notothecta flavipes, Gr.

Normal hosts.—*Formica rufa*, L., and *pratensis*, De G.

A single specimen was taken by Wasmann with *F. sanguinea* in May in Dutch Limburg. I took a specimen on the wing at Budleigh Salterton on January 22nd, 1896, it being a very warm, sunny day; and swept another in Darenth Wood on June 18th, 1908.

I have bred it in my *F. rufa* observation nest, and have shown it protects itself when attacked.

Notothecta confusa, Märk.

Normal host.—*Lasius fuliginosus*, Ltr.

I took a single specimen with *F. rufa* at Oxshott. ("Ent. Rec., 1905," p. 272.) These two species belong to the indifferently treated lodgers.

Quedius brevis, Er.

Normal hosts.—*Formica rufa*, L., and *Lasius fuliginosus*, Ltr.

A single specimen was taken in a nest of *F. sanguinea* at Woking by Champion (E. M. M. 1906, p. 255), and another with the same ant by H. W. Ellis at Bewdley. ("Ent. Rec., 1908," p. 57.)

Tuck took it in bees' nests at Tostock in 1896. ("Suffolk

List, 1899," p. 31.) I took a specimen in a sand-pit at Weybridge on 29th April, 1895. W. E. Sharp found a specimen under the bark of a tree near a nest of *F. rufa* at Burnham Beeches. ("Vic. Hist., Bucks., 1905," p. 76.) I found the larvae in some numbers in a nest of *Lasius fuliginosus* at Wellington College. I have bred it in my observation nest of *F. rufa* (two specimens came out of the nest this year, one on January 28th, and the second on February 19th), and have shown it protects itself from the ants.

This and the next species belong to the hostile persecuted lodgers.

Xantholinus atratus, Heer.

Normal hosts.—*Formica rufa*, L., *pratensis*, De G., and *Lasius fuliginosus*, Ltr.

Linnell records a specimen taken crawling in the sand of the cutting at Reigate tunnel in April 1865, and two specimens in a sand-pit at Dorking in April 1867. ("Reigate List, 1878," p. 44.)

The only British record with *L. fuliginosus* is that of Mr. H. W. Ellis at Knowle. ("Ent. Rec.," 1908, p. 57.)

Claviger testaceus, Preys.

Primary host.—*Lasius flavus*, De G.

Secondary hosts.—*Lasius alienus*, Först., and *niger*, L.

It was once found in a nest of *Tapinoma erraticum* by Von Hagens. Strübing found four specimens in a nest of *L. niger*, which appeared to have belonged to *L. flavus* and to have been taken by the former ants, a few specimens of the latter being still in the nest. The first specimen taken in Britain was captured by Professor Westwood in Oxfordshire on August 30th, 1838, in a nest of *L. flavus*. It was attached to a winged ♂ on the under-side. This suggests a possible method of being taken out of the old nest.

Although Müller in 1818 gave some account of the habits of the curious beetles of the genus *Claviger*, showing them to be true guests, etc. ("Germar's Mag.," III, pp. 57–112), nothing is known to this day of their true life history, of how and where the eggs are laid, or even of their larvae! The problem has been investigated by Janet, Wasmann, Hetschko, Schmitz and others without

success. I have kept many examples alive in my observation nests of *L. flavus* and *L. niger*, but have never been able to breed it. I saw it fed and licked by its hosts, and also feed on their larvae. I saw specimens riding on each other, but this does not imply copulation, as, as many as five or more Clavigers will all ride mounted on each other, the bottom one carrying them all; numbers also ride on their hosts.

At Portland, where I found it in numbers, I also saw specimens riding on each other in the nests. I introduced specimens there from *L. flavus* nests to *L. niger* nests and vice versâ, both near to each other and at a distance, and they were always accepted by the ants. I also obtained similar results in my observation nests at home, including *F. rufa*. Last year, however, specimens which I had taken with *L. flavus* at Dartmouth, introduced into an observation nest of *Tetramorium caespitum*, were attacked and killed by the ants.

Father Schmitz found that *C. longicornis* was received by most of the ants he introduced it to, except *F. rufibarbis* and *sanguinea*, which killed it.

When a nest is disturbed the ants often pick up the Clavigers and carry them into safety. Father Schmitz showed that *C. longicornis* was carried riding on the ants (*L. umbratus*), when he allowed them to enter a new nest. Professor Hetschko records *C. testaceus* as often attached to the winged ♀ ants, and suggests they may be spread to other and new nests through the marriage flight. He found the beetles could live away from ants when fed with dead flies, etc. Wasmann had already pointed out that they also fed on the ants' larvae. The beetles appear to hibernate in the nests.

It is very doubtful if the larva described by L. von Heyden ("Jahrb. Nass. Ver. Naturk," 1876-77, p. 201) is that of *Claviger* at all.

Dendrophilus pygmaeus, L.

Normal hosts.—*Formica rufa*, L., and *pratensis*, De G

Stephens recorded this species as taken in plenty in sand-pits on Hampstead Heath and gravel-pits in Coombe Wood. ("Mand." III, 1830, p. 160.)

I have bred specimens in my *F. rufa* observation nest, and have found the pupa in a nest of that ant at Haye Woods

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in May. The shape and hardness of this and the next species protect them from the ants. They belong to the indifferently treated guests, though *Myrmeces* is sometimes licked by its hosts.

Myrmeces piceus, Pk.

Normal hosts.—*Formica rufa*, L., and *pratensis*, De G.

Wasmann took a single specimen in a nest of *F. sanguinea*, which contained *rufa* as slaves in Dutch Limburg. I have bred this species in my *F. rufa* observation nest many times, and on May 10th, 1909, I noticed a pair in *cop.* in a small *Formica* observation nest, and also the licking of a specimen by an ant.

Amphotis marginata, F.

Normal host.—*Lasius fuliginosus*, Ltr.

Taken on the wing in the summer of 1906 at Woking by Champion. (E. M. M., 1906, p. 255.)

Cetonia floricola, Hbst.

Normal hosts (for larvae and pupa).—*Formica rufa*, L., and *pratensis*, De G.

A single larva was found by Wasmann in May in a nest of *Formica sanguinea*, and another with *L. fuliginosus* in Dutch Limburg. Wasmann has pointed out that the ♀ *Cetonia* lays her eggs in the ants' nests, and that she is attacked by the ants.

Rupertsberger describes the entrance of a ♀ *Cetonia* which he saw fly up, into a nest of *F. pratensis*, to lay her eggs. ("Wien Ent. Zeitg.," 1893, p. 249.)

Weaver recorded that the larvae lived in the nests of *F. rufa* in Scotland. (Trans. Ent. Soc. Lond., Nov. 1st, 1852.)

Lloyd records finding larvae and pupæ in nests of *F. rufa* at Rannoch. (E. M. M., 1892, p. 310.)

I found the empty pupa cases in the nests at Rannoch in June 1900, and larvae in some numbers in a *rufa* nest at Nethy Bridge last May.

W. Evans bred the beetle from larvae taken in *F. rufa* nests, Upper Forth. ("Ann. Scot. Nat. Hist.," 1903, p. 95.)

Clythra 4-punctata, L.

Normal host (for larva and pupa).—*Formica rufa*, L.

The larvae and pupae of this beetle are common in nests of *F. rufa*.

Father Wasmann records the seeking of nests by the beetles to lay eggs at Exaeteñ.

I have described the copulation of this beetle and also the eggs, young larvae, etc., and have shown that the ♀ lets fall her eggs on to the *rufo* nests, and that the ants pick them up and carry them into the galleries.

Besides the lists and periodicals mentioned in the above notes, I have consulted the following papers which bear on the subject:—

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- (1) "Über die Lebensweise einiger Ameisengäste."
I. Tl.—Deutsch. Ent. Ztschr., 1886, I, pp. 49–66.
- (2) "Über die Lebensweise einiger Ameisengäste."
II. Tl.—Deutsch. Ent. Ztschr., 1887, I, pp. 108–122.
- (5) "Beitrage zur Lebensweise der Gattungen *Atemeles* und *Lomechusa*."
Tijdschr. v. Entom., XXXI, pp. 245–328.
- (11) "Vergleichende Studien über Ameisengäste und Termitengäste."
Tijdschr. v. Entom. XXXIII, pp. 27–97.
- (17) "Eine neue Clavigeride aus Madagaskar . . . mit biologischen Bemerkungen."
Stett. Ent. Ztg., 1891, pp. 3–10.
- (18) "Verzeichnis der Ameisen und Ameisengäste von Holländisch-Limburg."
Tijdschr. v. Entom. XXXIV, pp. 39–64.
- (20) "Vorbemerkung zu den internationalen Beziehungen der Ameisengäste."
Biol. Zentralbl., XI, 1891. No. 11, pp. 331–343.
- (34) "Zur Lebens- und Entwicklungs-geschichte von *Atemeles pubicollis*, mit einem Nachtrag über *Atemeles emarginatus*."
Deutsch. Ent. Ztschr., 1894, II, pp. 281–283.
- (38) "Kritisches Verzeichnis der Myrmekophilen und termitophilen Arthropoden." Berlin, 1894.
- (45) "Zur Biologie von *Lomechusa strumosa*."
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- (70) "Zur Biologie der *Lomechusa*-Gruppe."
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- (75) "Zur Morphologie und Biologie der Lomechusa-Gruppe."
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- (83) "Erster Nachtrag zu der Ameisengäste von Hollandish-Limburg."
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- (105) "Weitere Nacträge zum Verzeichnis der Ameisengäste von Hollandish-Limburg."
Tijdschr. v. Entom., XLII, 1899, pp. 158-171.
- (109) "Über *Atemeles pubicollis* und die Pseudogynen von *Formica rufa*."
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- (131) "Neue Bestätigungen der Lomechusa-Pseudogynentheorie."
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- (146) "Ursprung und Entwicklung der Sklaverei bei den Ameisen."
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- (149) "Zur Lebensweise von *Atemeles pratensoides*."
Ztschr. wissensch. Insektenbiol., II, 1906, Heft. 1 and 2.
- (162) "Weitere Beitrage zum sozialen Parasitismus und der Sklaverei bei den Ameisen."
Biol. Zentralblatt., 1908. No. 8-13.
- (164) "Die psychischen Fähigkeiten der Ameisen."
Second Edt., Stuttgart, 1909.
- (166) "Nachtrag zu: Weitere Beitrage zur sozialen Parasitismus und der Sklaverei bei den Ameisen."
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- "*Claviger longicornis*, Müll., sein Verhaltnis zur *Lasius umbratus*."
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4 and 5.

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- (10) "On the Origin of, and Progression in, the study of Myrmecophilous Coleoptera."
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- (11) "On Some Experiments with Myrmecophilous Coleoptera."
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- (13) "The Life History of *Clythra 4-punctata*, L."
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- (15) "Further Experiments with Myrmecophilous Coleoptera, etc."
Ent. Rec., 1903, pp. 11-12.
- (16) "Notes on the Myrmecophilous Habits of *Cetonia aurata*, L."
Ent. Rec., 1904, p. 301.
- (25) "The Life History and Occurrence as British of *Lomechusa strumosa*, F."
Trans. Ent. Soc. Lond., 1907, Pl. IV (Jan. 1908), pp. 415-520.

In conclusion, I must express my best thanks to Father Wasmann for his kind help in letters, and by pointing out which of his papers I should find most useful to consult on this subject; and to Professor Poulton for kind suggestions and revising some of this paper for me.

